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(54) **Strip line resonator**

(57) A strip line resonator includes a dielectric substrate 101 having a grounding conductor 105 on its lower surface and further a ring-like strip line 102 on its upper surface. The dielectric substrate has a through-hole 104 at a center portion of the ring-like strip line and the ring-like strip line is slit at a portion 115 thereof so as to form two open end portions. Also included in the resonator is a rotatable disc 300 having on its upper surface an electrode 107 which is formed along a portion of the circumference thereof so as to have a tapered configuration. The rotatable disc similarly has a through-hole at its center portion. The dielectric substrate and the rotatable disc are combined with each other by inserting a connecting member thereinto with the through-holes thereof being aligned with each other so that the rotatable disc is rotatable with respect to the dielectric substrate and a capacitance is developed between the electrode of the rotatable disc and the two open end portions of the strip line. A plurality of resonators may form a filter (Fig. 5).

FIG. 1

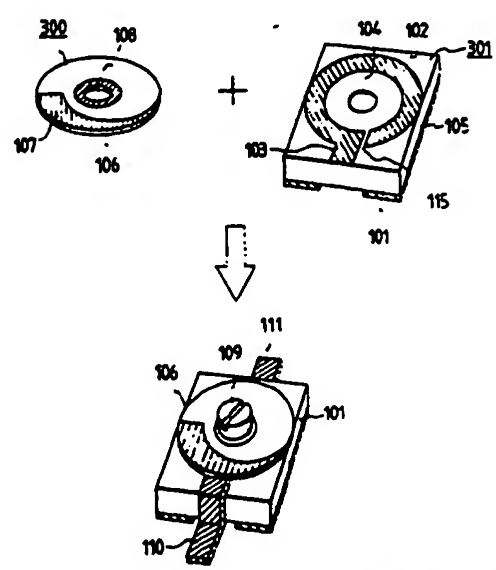

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FIG. 1

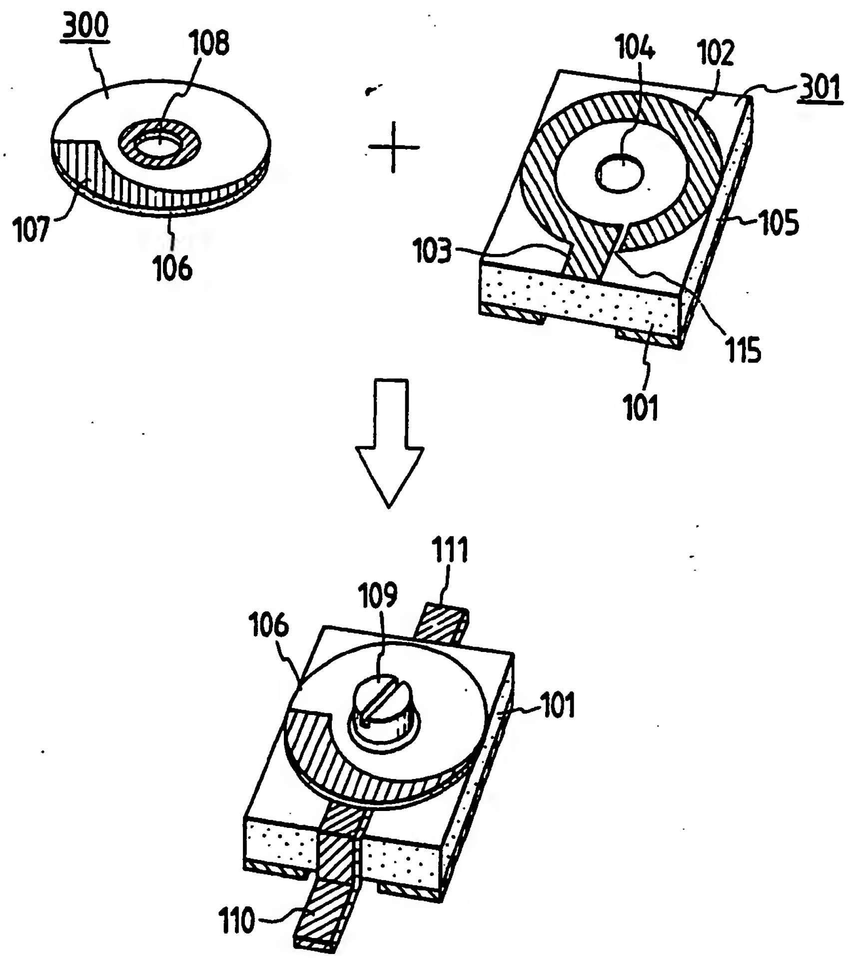

FIG. 2

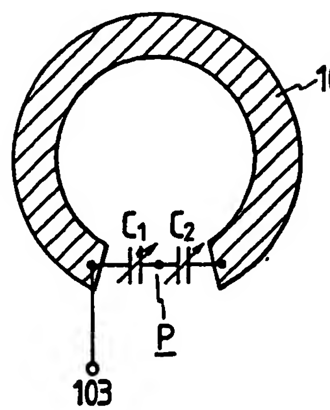

FIG. 3

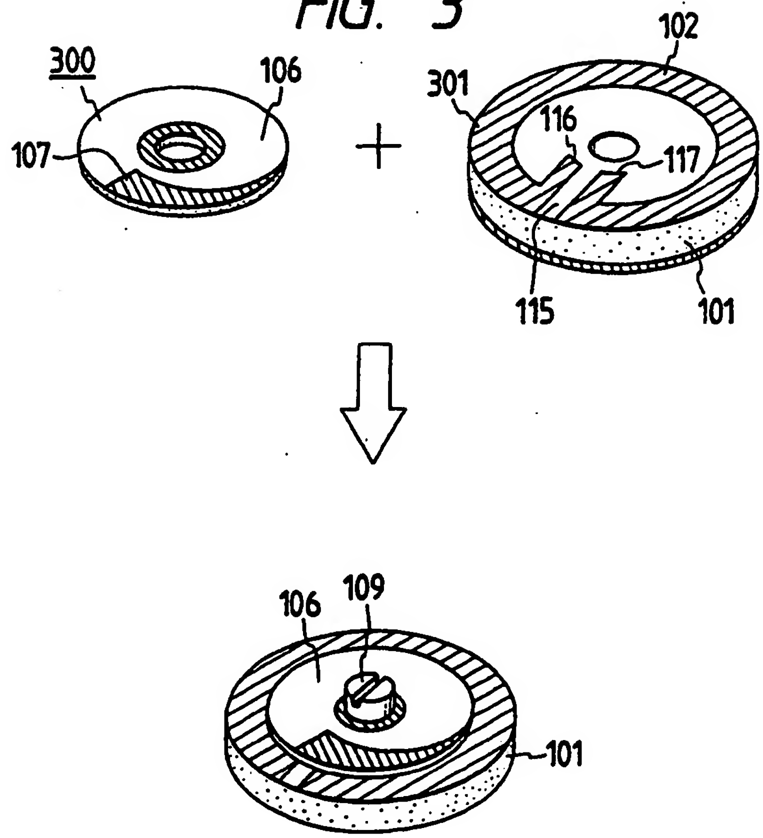

FIG. 4

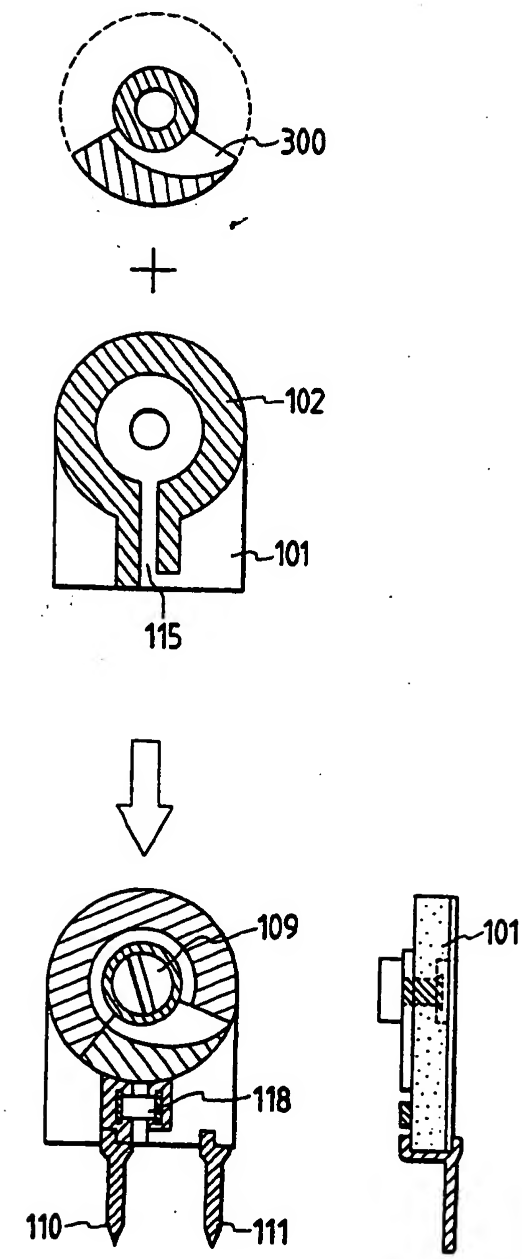

FIG. 5

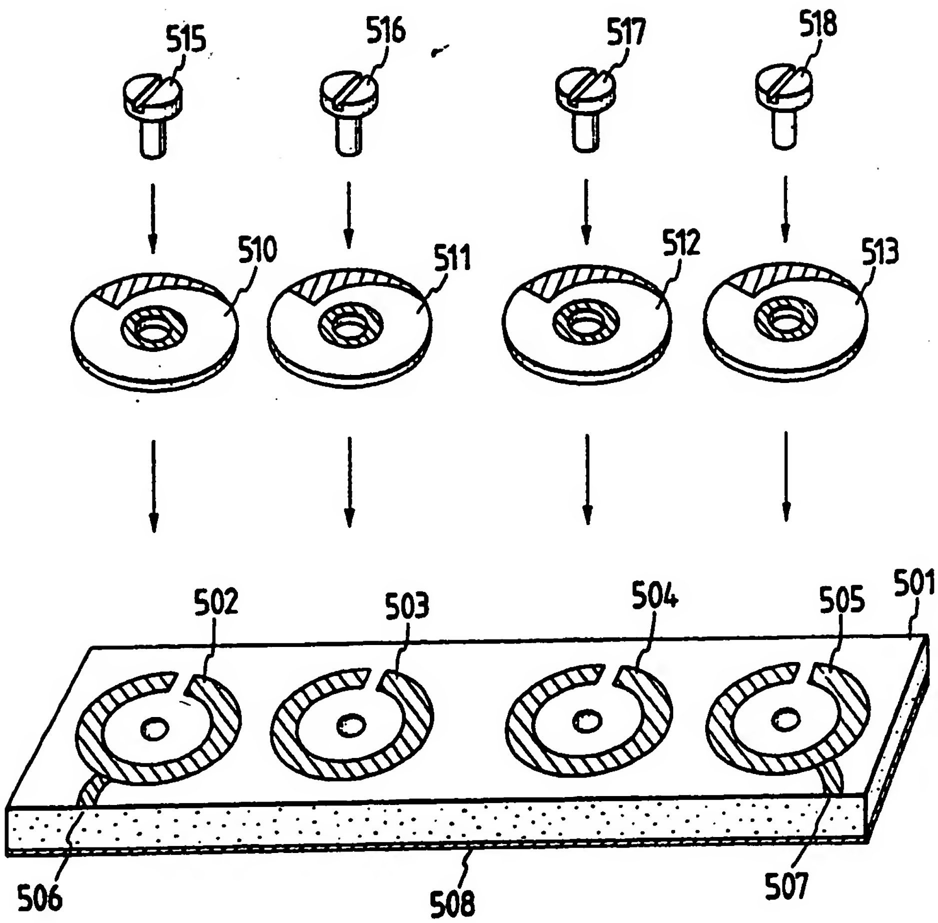

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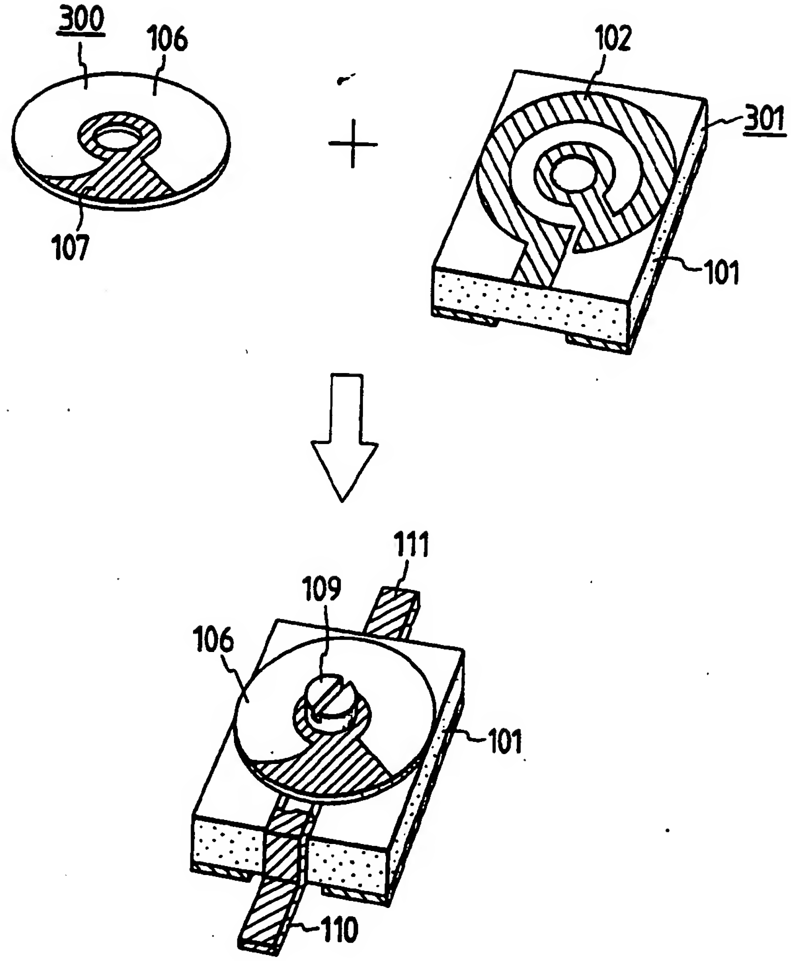
FIG. 6



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TITLE OF THE INVENTION

ARRANGEMENT OF STRIP LINE RESONATOR

BACKGROUND OF THE INVENTION

The present invention relates to arrangements of a strip or microstrip line resonator for use in high frequency equipment such as oscillator, filter and others.

Strip or microstrip resonators require that for high frequency (for example, UHF) equipment there be a minimum amount of loss and size-reduction. U.S. Patent 4,749,963 discloses a ring type strip line resonator which is capable of facilitating frequency adjustment. However, such a strip line resonator is applicable under only the condition that the resonator line length is sufficiently greater than the diameter of a rotatable disc and its frequency-variable range is relatively narrow.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a strip resonator which is capable of making wide the frequency-variable range and making smooth the capacitance variation.

In accordance with the present invention, there is provided a strip line resonator comprising: a dielectric substrate having a grounding conductor on its lower surface and further a ring-like strip line on its upper surface, the dielectric substrate having a through-hole at a center

portion of the ring-like strip line and the ring-like strip line being slit at a portion thereof so as to form two open end portions; and a rotatable disc having on its upper surface an electrode which is formed along a portion of the circumference thereof so as to have a tapered configuration, the rotatable disc having a through-hole at its center portion, wherein the dielectric substrate and the rotatable disc are combined with each other by inserting a connecting member thereinto with the through-holes thereof being aligned with each other so that the rotatable disc is rotatable with respect to the dielectric substrate and a capacitance is developed between the electrode of the rotatable disc and the two open end portions of the strip line.

In accordance with the present invention, there is also provided a strip line resonator comprising: a dielectric substrate having a grounding conductor on its lower surface and further a ring-like strip line on its upper surface, said dielectric substrate having a through-hole at a center portion of said ring-like strip line and said ring-like strip line being slit at a portion thereof so as to form two open end portions; and a rotatable member formed in form of a sector and having on its upper surface an electrode which is formed along an arc portion thereof so as to have a tapered configuration, said

rotatable member having a through-hole at its pivot portion, wherein said dielectric substrate and said rotatable member are combined with each other by inserting a connecting member thereinto with said through-holes thereof being aligned with each other so that said rotatable disc is rotatable with respect to said dielectric substrate and a capacitance is developed between said electrode of said rotatable member and said two open end portions of said strip line.

In accordance with the present invention, there is further provided a strip line resonator comprising: a dielectric substrate having a grounding conductor on its lower surface and further a plurality of ring-like strip lines on its upper surface, said dielectric substrate having a plurality of through-holes at a center portion of each of said ring-like strip lines and each of said ring-like strip line being slit at a portion thereof so as to form two open end portions; and a plurality of rotatable discs each having on its upper surface an electrode which is formed along a portion of the circumference thereof so as to have a tapered configuration, each of said rotatable disc having a through-hole at its center portion, wherein said dielectric substrate and said rotatable disc are combined with each other by inserting connecting members thereinto with said through-hole of each of said rotatable

discs and each of said through-holes of said dielectric substrate being aligned with each other so that each of said rotatable discs is rotatable with respect to said dielectric substrate and a capacitance is developed between said electrode of each of said rotatable discs and said two open end portions of each of said strip lines, whereby said strip line resonator acts as a filter.

BRIEF DESCRIPTION OF THE DRAWINGS

The object and features of the present invention will become more readily apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

Fig. 1 is an exploded perspective view showing a strip line resonator according to a first embodiment of the present invention;

Fig. 2 is an illustration of an electrically equivalent circuit of the Fig. 1 resonator;

Figs. 3 and 4 are exploded perspective views of strip line resonators according to second and third embodiments of this invention; and

Figs. 5 and 6 are exploded perspective views of filters provided with the resonators of this invention.

DETAILED DESCRIPTION OF THE INVENTION

A strip line resonator according to a first embodiment of this invention will be described hereinbelow

with reference to Figs. 1 and 2, Fig. 1 being an exploded perspective view of the first embodiment resonator and Fig. 2 being an illustration of an electrical equivalent circuit of the Fig. 1 resonator. In Fig. 1, illustrated at numeral 301 is a ring-like resonator including a dielectric substrate 101, which are metallized so as to form a grounding conductor 105 on its lower surface and a ring-shaped strip line 102 on its upper surface. A through-hole 104 is formed at a portion of the resonator corresponding to the center portion of the ring-shaped strip line 102. The ring-shaped strip line 102 has a slit portion 115 so as to form two open ends, one of which is connected to an output terminal 103 extending up to an end portion of the dielectric conductor 101. On the other hand, illustrated at numeral 300 is a rotatable disc including a disc-like dielectric member 106 whose diameter is substantially equal to the ring diameter of the strip line 102 and which is metallized so as to form an electrode 107 on its upper surface. The flat electrode 107 is substantially formed along the circumference of the disc-like dielectric member 106 so as to have a curved and tapered configuration. A through-hole 108 is formed at the center portion of the disc-like dielectric member 106.

The ring-like resonator 301 and the rotatable disc 300 are coupled to each other with the through-holes 104

and 108 being aligned with each other and a pressure-adhesion fixing pin 109 being inserted thereinto, thereby resulting in formation of a strip line resonator. To the output terminal 103 and grounding conductor 105 are respectively coupled flat-plate type lead terminals 110 and 111 which are in turn used for connection to other devices or circuits. The disc-like dielectric member 106 is mechanically fixed with the fixing pin 109 so as to be rotatable together with the fixing pin 109. When the electrode 107 is positioned above the slit portion 115 of the strip line resonator, two capacitances are developed between the two open ends of the strip line 102 and the electrode 107 so as to be connected in series to each other. Thus, the equivalent circuit of this resonator results in being illustrated in Fig. 2. In Fig. 2, characters C1 and C2 respectively represents the two capacitances (capacitors) formed between the two open ends and the electrode 107 illustrated at character P. With rotation of the disc-like dielectric member 106, C1 and C2 can vary at the same time to allow variation of the resonance frequency. Here, since the electrode 107 is arranged to have a tapered configuration, the capacitance variation becomes smooth over a wide range.

Fig. 3 is an exploded perspective view for describing a second embodiment of this invention, in which

parts corresponding to those in Fig. 1 are marked with the same numerals and the description thereof will be omitted for brevity. One different point of the Fig. 3 resonator from the Fig. 1 resonator is that the diameter of a ring-like resonator 301 is equal to or greater than that of a rotatable disc 300. In Fig. 3, on the upper surface of a disc-like dielectric substrate 101 of the ring-like resonator 301 is metallized a ring-like strip line 102 which is similarly arranged so as to have a slit portion 115 to form two open ends which are respectively connected to two electrodes 116 and 117 exdending toward the inside of the ring-like strip line 102. On the other hand, a dielectric member 106 of the rotatable disc 300 has the same structure as that illistrated in Fig. 1. Similarly, the rotatable disc 300 and ring-like resonator 301 are coupled with each other with the centers thereof being aligned with each other through a fixing pin 109.

With the above-mentioned arrangement, the capacitance variation can be realized through parallel flat-plate capacities between the electrode 107 and the electrodes 116, 117. This arrangement can realize a variable tuning ring-like resonator which is capable of having a long line. Here, the output terminal of this resonator can be provided at a given portion of the strip line 102.

Fig. 4 is an exploded perspective view for describing a third embodiment of this invention, the resonator of Fig. 4 being of the vertically mounting type that has a resonance frequency coarse control function. In Fig. 4, a rotatable disc 300 having an electrode on its upper surface has a sectorial configuration, resulting in reduction of the material cost, and is arranged so that a slit 115 of a strip line 102 can be trimmed in order to vary the resonator length. Further, both open ends of the strip line 102 extend in parallel with each other toward the outside of the ring-like strip line 102 and a fixed capacitance 118 is provided therebetween as illustrated in the Figure, thereby allowing the resonance frequency coarse control. Numerals 110 and 111 represent a output terminal pin and a grounding terminal pin 111 which are in turn coupled to other circuits.

Fig. 5 is an exploded perspective view for describing a fourth embodiment of this invention, where a plurality of resonators are disposed on the same substrate 501. The fourth embodiment may be applicable to a four-step band-pass filter. As illustrated in Fig. 5, a plurality of ring-like resonators 502 to 505 are formed on the one-piece substrate 501 and further rotatable discs 510 to 513 for adjustment of the resonance frequency are respectively mounted on the ring-like resonators 502 to 505

and the substrate 501 through fixing pins 515 to 518. On the lower surface of the substrate 501 are provided a grounding conductor 508 and input and output terminals 506, 507. The band characteristic of this filter depends upon the interval of the resonators 502 to 505. Here, it is appropriate that a single resonator and an active circuit are formed thereon so as to realize an oscillating circuit or others.

Fig. 6 is an exploded perspective view for describing a fifth embodiment of this invention. One difference in arrangement between this embodiment and the first to fourth embodiments is that a λ g/4 type resonator can be realized. In Fig. 6, a strip line 102 is similarly formed on a dielectric substrate 101, while in this embodiment one end of the strip line 102 is shorted at the center portion of the dielectric substrate 101 and the other end thereof is arranged to be an opened end so as to realize a quarter wavelength type resonator. A rotatable disc 106 similarly has tapered electrode 107, whereas the electrode 107 is shorted at the center portion of the rotatable disc 106. That is, the upper electrode is arrange to act as a grounding electrode. The dielectric substrate 101 and the rotatable disc 106 are combined with each other to finally construct a quarter wavelength type resonator as illustrated in Fig. 6. In this instance, the

resonance frequency can be changed with the variable capacitance at the open end portion. This quarter wavelength type variable tuning resonator can take an extremely wide frequency-variable range.

It should be understood that the foregoing relates to only preferred embodiments of the present invention, and that it is intended to cover all changes and modifications of the embodiments of this invention herein used for the purposes of the disclosure, which do not constitute departures from the spirit and scope of the invention.

CLAIMS

1. A strip line resonator comprising a dielectric substrate having a grounding conductor on one surface and on its other surface a ring-like strip line which is split to form two open end portions, and an electrode bearing member which is rotatable about an axis passing through the centre of the ring, the electrode being shaped such that the radial extent of the electrode varies in the direction of rotation and the member being disposed relative to the dielectric substrate such that, in use, capacitance is developed between the electrode and the two open end portions of the strip line.

2. A resonator according to claim 1 wherein the electrode tapers in the direction of rotation.

3. A strip line resonator comprising:

a dielectric substrate having a grounding conductor on its lower surface and further a ring-like strip line on its upper surface, the dielectric substrate having a through-hole at a centre portion of the ring-like strip line and the ring-like strip line being slit so as to form two open end portions; and

a rotatable disc member having on its upper surface an electrode which is formed along a portion of the circumference thereof so as to have a tapered configuration, the rotatable disc member having a through-hole at its centre portion,

wherein the dielectric substrate and the rotatable disc are combined with each other by inserting a connecting

member thereinto with the through-holes thereof being aligned with each other so that the disc is rotatable with respect to the dielectric substrate and a capacitance is developed between the electrode and the two open end portions of the strip line.

4. A strip line resonator according to any one of claims 1 to 3, wherein the diameter of the strip line is substantially equal to that of the rotatable disc member.

5. A strip line resonator according to any one of claims 1 to 3, wherein the diameter of the rotatable member is equal to or smaller than the inner diameter of the ring-like strip line and the open ends of the said strip line extend toward the centre portion thereof so as to develope a capacitance with respect to the electrode.

6. A strip line resonator according to any one of claims 1 to 5 wherein an output lead terminal is connected to the one open end of the strip line and a grounding lead terminal is connected to the grounding conductor of the dielectric substrate so as to allow vertical mounting or horizontal mounting with respect to other devices.

7. A strip line resonator according to any one of claims 1 to 6 wherein the one open end of the strip line is shorted and the other open end is kept to be in an open state and the electrode of the rotatable member is grounded, so that variation of capacitance is allowed between the electrode and the open end portions so as to act as a quarter wavelength type resonator.

8. A strip line resonator comprising:

a dielectric substrate having a grounding conductor on its lower surface and further a ring-like strip line on its upper surface, the dielectric substrate having a through-hole at a centre portion of the ring-like strip line and the ring-like strip line being slit so as to form two open end portions; and

a rotatable member formed in form of a sector and having on its upper surface an electrode which is formed along an arc portion thereof so as to have a tapered configuration, the rotatable member having a through-hole at its pivot portion;

wherein the dielectric substrate and the rotatable member are combined with each other by inserting a connecting member thereinto with the through-holes thereof being aligned with each other so that the rotatable member is rotatable with respect to the dielectric substrate and a capacitance is developed between the electrode and the two open end portions of the strip line.

9. A strip line resonator comprising:

a dielectric substrate having a grounding conductor on its lower surface and further a plurality of ring-like strip lines on its upper surface, the dielectric substrate having a plurality of through-holes at a centre portion of each of the ring-like strip lines and each of the ring-like strip line being slit so as to form two open end portions; and

a plurality of rotatable disc members each having on its

upper surface an electrode which is formed along a portion of the circumference thereof so as to have a tapered configuration, each of the rotatable members having a through-hole at its centre portion,

wherein the dielectric substrate and the rotatable members are combined with each other by inserting connecting members thereinto with the through-hole of each member and each of the through-holes of the dielectric substrate being aligned with each other so that each rotatable member is rotatable with respect to the dielectric substrate and a capacitance is developed between the electrode of each rotatable member and the two open end portions of the associated strip line, wherein the strip line resonator acts as a filter.

10. A strip line resonator constructed and arranged substantially as herein described with reference to and as illustrated in the accompanying drawings.

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